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The Chinese Beryllium Industry (U)

A Defense Research Assessment

Defense Intelligence Agency

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The Chinese Beryllium Industry (U)

A Defense Research Assessment

This is a Department of Defense Intelligence Document
Prepared by the (b)(3):10 USC 424
Directorate for Research, Defense Intelligence Agency

(b)(2),(b)(3):10 USC 424 [redacted]

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The Chinese Beryllium Industry (U)

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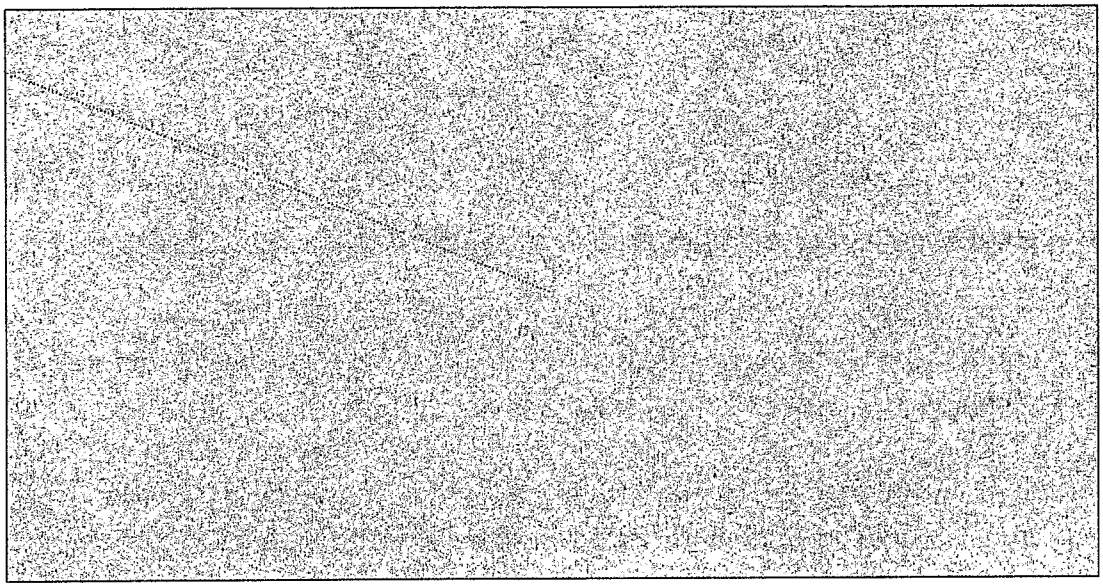

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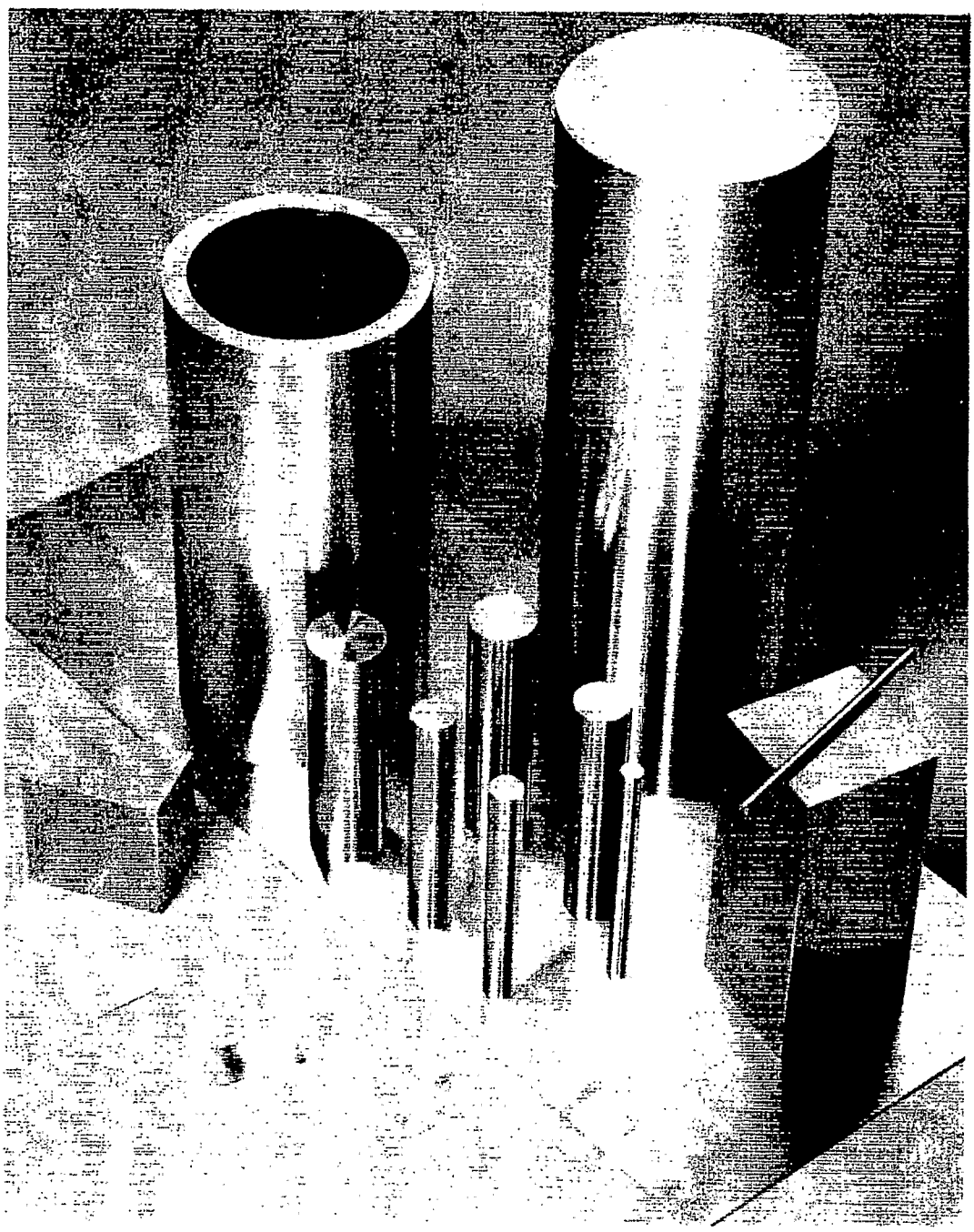


(U) Milled Beryllium Products. *Generally, beryllium is easily machined to intricate forms, maintaining exellent surface finishes and close tolerances.*

The Chinese Beryllium Industry (U)

(b)(1),1.4
(h)

Background

(U) Beryllium is a high-strength, light-weight metal with excellent anticorrosion characteristics. The metal has great stiffness, exceeding that of other metals, including steel; a very high strength-to-weight ratio; significant nuclear moderating and reflecting properties; corrosion resistance; and important heat dissipation properties. Beryllium oxide (beryllia), displays thermal shock resistance and electrical insulating properties, microwave radiation transmission capabilities, and thermal conductivity. These characteristics have made beryllium invaluable in the development of a wide range of advanced aerospace, electronic, and nuclear- industry-related products.

(U) Beryllium has numerous and diversified uses. A large percentage of beryllium production is in the form of beryllium-copper and other alloys used in the electronics industry. Beryllium is also utilized in its metallic and oxide forms. Beryllium products can be used as substrates for electronic circuits, as heat sinks, and as electronic connectors. Aerospace applications include incorporation in structural components of missiles, aircraft frames, satellite components, and inertial navigational systems for missiles and aircraft. Other uses include molds for plastics; dies; high-strength, nonsparking tools; tubes; measuring instruments; and X-ray radiation windows.

~~(S)~~ Beryllium is used for a number of nuclear applications and plays an important role in the development of atomic power and nuclear weapons.

(b)(1),1.4
(h)

~~(S/NF)~~ Only three countries produce industrial-scale beryllium metal, the USSR, the United States, and China.

(b)(1),1.4
(c)

which produces very small amounts of the metal. (Brazil and India have small-scale pilot plants for the production of beryllium metal.)

~~(S/NF/WN)~~ A review of recent literature reveals a variety of Chinese uses for beryllium products. In its various forms, the Chinese have used or experimented with the use of beryllium materials in windows, scanners, antennas, and heat sinks for satellites; in rotating mirrors for ultra-high-speed cameras; in gyroscopes; and in parts for shipboard navigation equipment.

(b)(1),1.4
(c)

Deposits, Ore Extraction, and Processing

(U) Beryllium occurs as an essential constituent in about 40 minerals and as an occasional constituent in 50 others. Beryl, bertrandite, barylite, and chrysoberyl are some of the more commonly known beryllium minerals. In China, beryl is the principal beryllium resource.

~~(C/NF/WN)~~ Commercial sources of beryl are generally heterogeneous granite pegmatites, where the mineral occurs in enriched zones, filled fractures, or replacement bodies. In China, the most extensive reserves are found in large rare

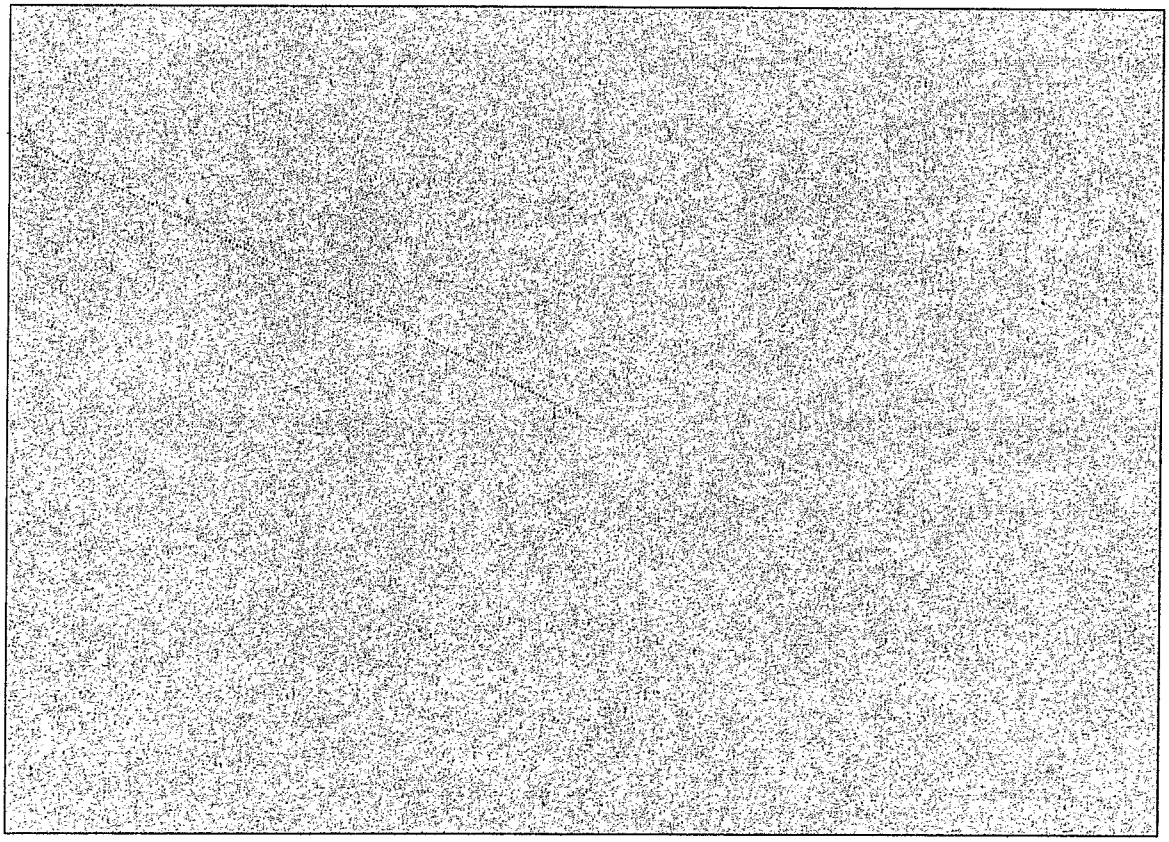
metal pegmatites in the Altai Mountains, in Xinjiang Province, not far from the China-Soviet border. Significant disseminated beryl deposits have also been reported in extreme southern Hubei Province. In southern Hunan Province, albitized granites and greisens with significant impregnations of beryl have been noted. Still other deposits of beryl have been identified in eastern Hunan, in tungsten mining areas of Jiangxi Province, and in Guangdong Province east of Guangzhou (Canton). Also believed to possess beryllium are pegmatites in Inner Mongolia and northeastern China and the rare-earth ores of Yunnan Province in the southwest. Although information is incomplete, some experts believe that China's beryl deposits are among the largest in the world.

(C/NF/WN) China's beryllium industry began in the 1930s when the Chinese, with Soviet assistance, located and began to develop deposits and mines. By 1945, almost all of China's beryl ore (1,000 to 3,000 metric tons) was exported to the USSR. This trading activity apparently continued until the early 1960s, when political differences between the two countries led to the suspension of beryl sales and the closing of some of the mines.

(C/NF/WN) As China's demand for beryllium and associated minerals, such as lithium and tantalum, increased, mining operations were expanded. Today, most of China's beryllium-producing mines are the shaft type, where beryl crystals are removed by hand separation. The majority of these mines have been developed to recover minerals other than beryllium (which is acquired as a coproduct or byproduct), and they are located in south and southwest China in the provinces of Hunan, Hubei, Jiangxi, and Guangdong.

(S/NF/WN) The largest beryllium mine in China, however, is the open-pit mine near Koktokay (Kokotohai), in Xinjiang Province, about 600 km north of Urumqi and only 300 km from

(b)(1),1.4 (c)



(b)(2) the Sino-Soviet border. The Kokotohai Light Metals Mine Koktokay [redacted] is operated by the Xinjiang Nonferrous Metals Corporation and, in addition to beryllium, produces tantalite, spondumene, mica, and feldspar. The mine is said to produce 1,000 to 2,000 metric tons of ore per year (8 to 12 percent beryllium oxide), or up to two-thirds of China's total. It is concentrated at the Kokotohai Light Metals Concentration Plant (b)(2) [redacted] by a unique Chinese flotation process and trucked to the railhead at Urumqi for further disposition. Although reserves at this mine are not known, an onsite observer has estimated that at least 15 million metric tons of ore are available for future processing.

~~(S/NF)~~ In addition to Kokotohai, several smaller mines have been developed in Xinjiang Province. These facilities have generally been mined only in the summer and have produced high-grade, hand-cobbed ore. Total output of these mines has been estimated at less than 20 percent of the production at Kokotohai.

~~(S/NF/WN/NC)~~ China has exported some of its beryllium in the form of ore or concentrates, but demand from the emerging aerospace, electronics, and nuclear industries has increased the domestic need for processed materials. To provide these products, China has built its own beryllium processing facility, which is probably the third-largest of its kind in the world. Located at the Shuikoushan Mining and Metallurgical Complex in Hunan Province, [redacted] The plant was built in 1957, with Soviet assistance, and has been described by visitors as old and somewhat out of date. The Chinese claim the plant is capable of processing between 600 and 1,000 metric tons of concen-

(b)(1),1.4 (c) [redacted]

(b)(1),1.4
(c)

centrate annually. [redacted] The facility is run by the National Nonferrous Metal Corporation, Hunan, and operates at a [redacted]

(b)(1),1.4
(c)

[redacted] The 8 to 10 percent beryllium ore is acquired from mines in the provinces of Hunan, Guangdong, Jiangxi, Hubei, and possibly Xinjiang. [redacted]

(b)(1),1.4
(c)

[redacted]

(S/NF/WN) Although the Shuikoushan Plant is China's only major beryllium processing facility, other installations have been associated with beryllium-related production. [redacted]

(b)(2)

[redacted] (Deqing Probable Rare Earth Plant, Chujiang [redacted] located in the western suburbs of Deqing, Guangdong Province, processes ore which contains some beryllium. As part of rare-earth separation operations, a beryllium concentrate is acquired and shipped to an unidentified location in Hunan Province (possibly Shuikoushan) for further processing.

(S/NF/WN) The Shanghai Nonferrous Metals Fabrication Plant [redacted] in the city of Shanghai, can produce about 160 metric tons of beryllium-copper alloy each year. This plant utilizes a 150-kg capacity melting furnace of early 1960s' vintage to produce its products. The Xibei Copper Fabrication Plant in Lanzhou, Gansu Province, may also produce beryllium-copper master alloy.

(b)(2)

(S/NF/NC) Another beryllium-associated facility is located somewhere in Ningxia Province. The plant acquires beryllium pebble from Shuikoushan, but the type and amount of final product is unknown. [redacted]

(b)(2)

(C) Although information is incomplete, the Chinese press has occasionally mentioned a new beryllium oxide plant in Xinjiang Province. However, the status and location of this plant are not certain. The Chinese have been attempting to acquire foreign assistance and technology to develop a 100-metric-ton-per-year beryllium-oxide processing plant in Xinjiang for several years. References to a production plant may, therefore, pertain to ongoing negotiations or development plans, rather than an existing facility.

Beryllium Sales

(S/NF/WN/NC) China has exported beryl for many years, although the total amount of sales is unknown. During the early period of the industry's development, materials not required for domestic use were exported, primarily to the Soviet Union. After the Sino-Soviet rift, however, mines were closed and production decreased. There is evidence of Chinese beryllium sales to European purchasers in the late 1960s, but a specific trading pattern for that time is not apparent. In the mid-1970s, China offered beryllium-copper master alloy at the Canton Trade Fair. Later, in 1980, after the China National Metallurgical Import/Export Corporation was established, both beryllium oxide and beryllium metal were made available for sale.

(S/NF/WN/NC) The Chinese have become more active in the beryllium market since the early 1980s. In 1982, a delegation from Hunan Province visited firms in the United States and arranged the sale of 30 metric tons of beryllium-copper alloy. In that same year, the Chinese Ministry of Foreign Economic Relations negotiated a sale to a US producer that included both traditional beryllium crystals and a powdered beryl concentrate produced in Xinjiang. With this agreement, the Chinese became, for a short time, the major foreign source of beryl for the United States. The annual availability of Chinese concentrate was estimated at about 1,000 metric tons.

(S/NF/WN/NC) The Chinese have become a less important source of beryllium for the United States, due to the inability of US consumers to utilize the powdered Chinese concentrate (after a furnace built for this purpose became inoperable) and the availability of supplies from other sources, such as Brazil. Although the export of Chinese beryl has continued, China has been developing

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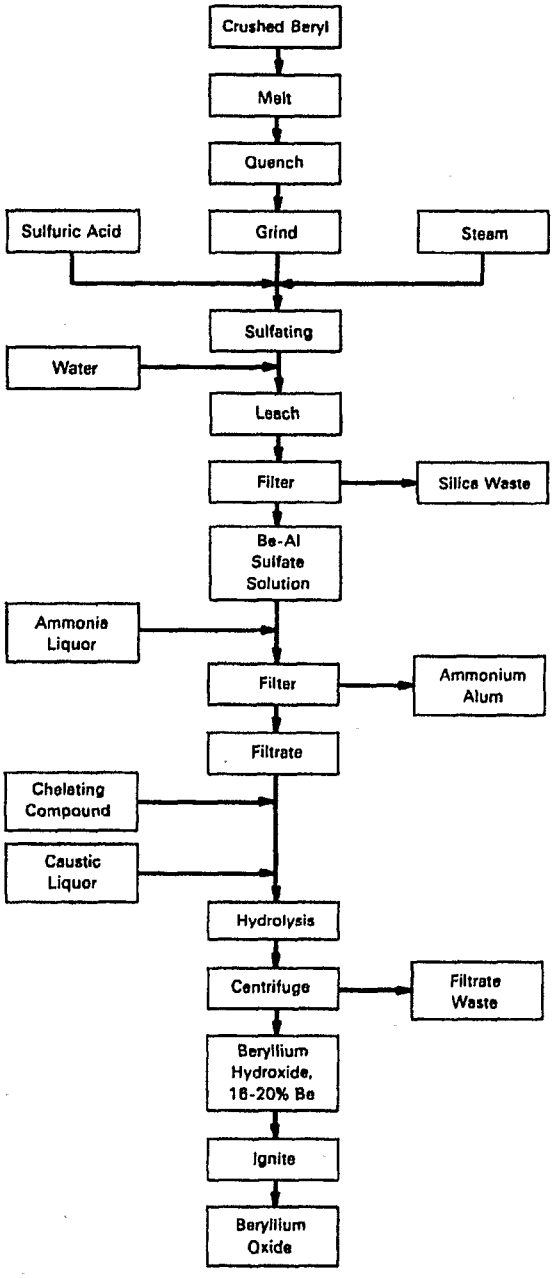
Beryllium Metallurgy



(U) This flow sheet charts the extraction of beryllium oxide, BeO, from beryl by the sulfate process.

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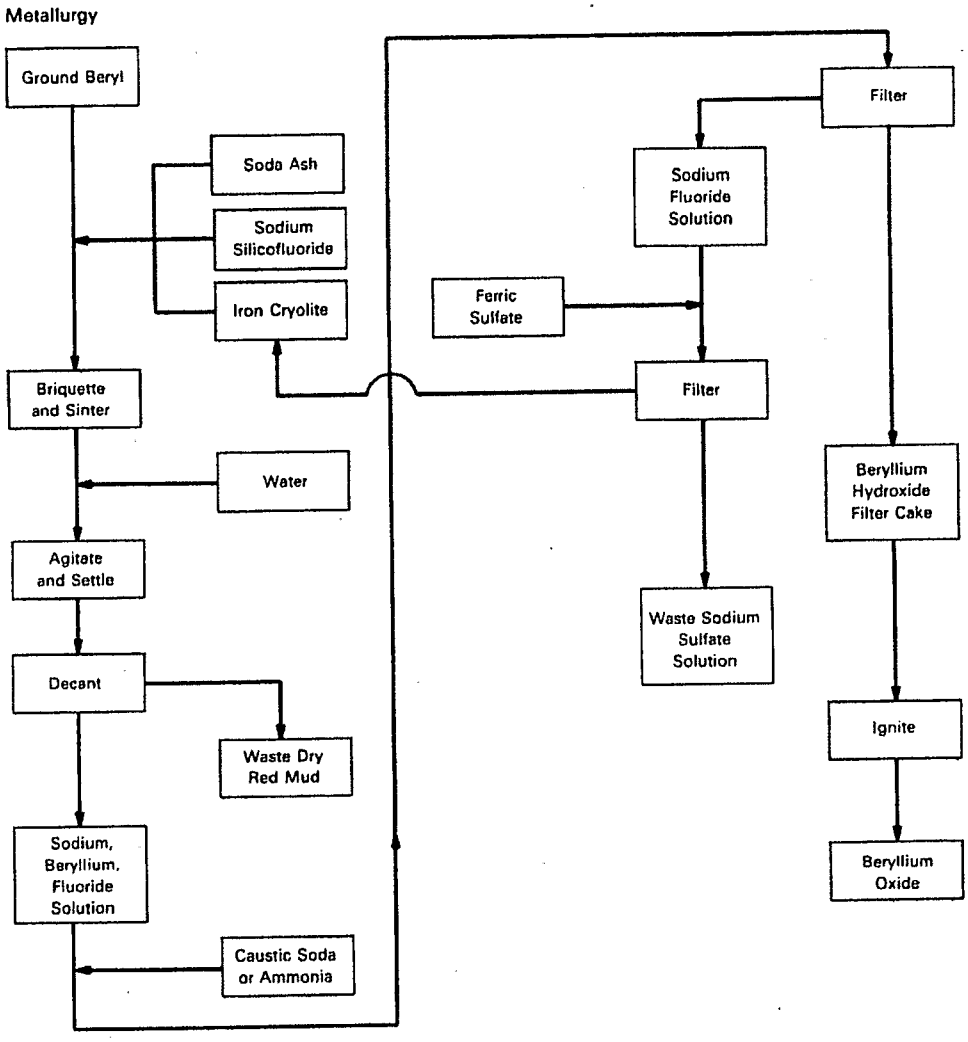
Beryllium Metallurgy



(U) This flow sheet charts the extraction of BeO from beryl by means of the fluoride process.

other markets — including Japan, Europe, and the Soviet Union — for their excess beryllium-related materials. (Although specific information is lacking, beryllium-related sales also may have been concluded with other countries — such as Brazil, Pakistan, and possibly South Africa — with which China has a known, or suspected, trading relationship and which are involved in indigenous nuclear development programs.)

Technology Transfer and Development Policy

~~(S/NF/WN)~~ Since the mid-1960s, when relations between the Chinese and the Soviet Union became strained, the Chinese have sought beryllium-related technology and products from Free World countries.

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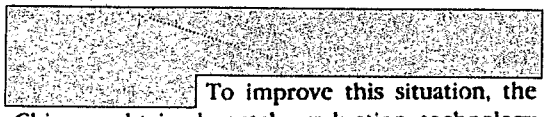

To improve this situation, the Chinese obtained metal production technology from Japan and high-purity metal from France. An expanded metal production capability was eventually attained, at least by 1979, when a Chinese official revealed that beryllium metal was one of the materials to be made available for foreign sales.

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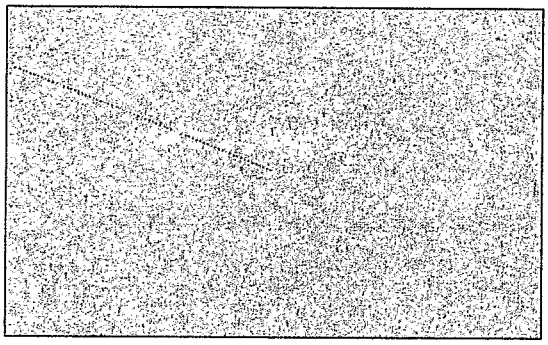
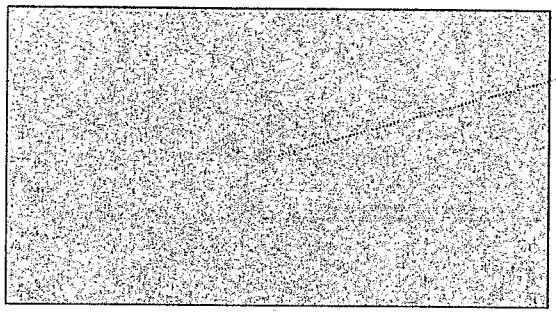


~~(C/NF/WN)~~ Although the development of the beryllium industry could provide badly needed foreign currency, the driving force behind these initiatives is probably the technological improvement of China's aerospace, nuclear, and electronics industries. This goal was noted in 1982, when a Chinese engineer stated that his country intended to promote the development of beryllium oxide and metal for advanced applications — such as lightweight, heat-resistant structural materials for aircraft and rockets; reflectors and cladding for reactors; and state-of-the-art electronics.

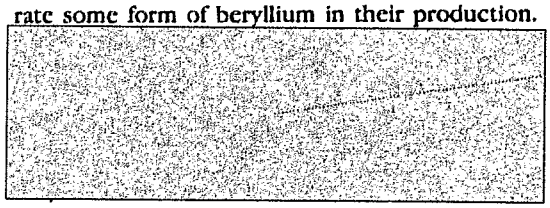
~~(C/NF/WN/NC)~~ To implement this policy, the Chinese continue to seek foreign assistance for beryllium-related projects. Chinese scientists and program managers have toured beryllium-associated facilities in Japan and the United States and have, in some cases, discussed the establishment of joint ventures for the development of deposits or production facilities. In the hope of stimulating interest in various development projects, the Chinese have, uncharacteristically, opened mines and plants for outside inspection and evaluation. Recently, Chinese officials began negotiating the renovation of an inactive beryllium mine and the construction of a processing plant in Xinjiang. Representatives from Hunan have expressed interest in improving and expanding the production facility at Shuikoushan. In a related development, an official of the Materials Institute in Beijing requested information on US companies, hoping to promote an exchange of personnel and the acquisition of information concerning the improvement of mining and processing techniques.

Conclusions



(b)(1),1.4 (d)

~~(C/NF)~~ A review of Chinese publications reveals an expanding list of products that incorporate some form of beryllium in their production.



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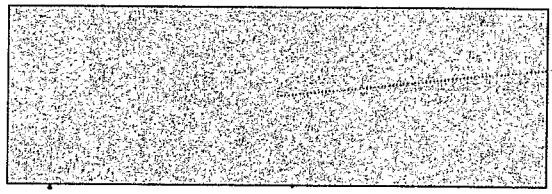

(b)(1),1.4 (d)

Physical Properties of Beryllium (U)

Property	Value
Atomic number	4
Atomic weight	9.0122
Crystal structure	Hexagonal, close-packed
Melting point	2,345 °F
Boiling point	5,378 °F
Heat of fusion	250-275 cal/g
Heat of vaporization	53,490 cal/mole
Electrical conductivity	40-44% of that of copper

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